CML Microcircuits

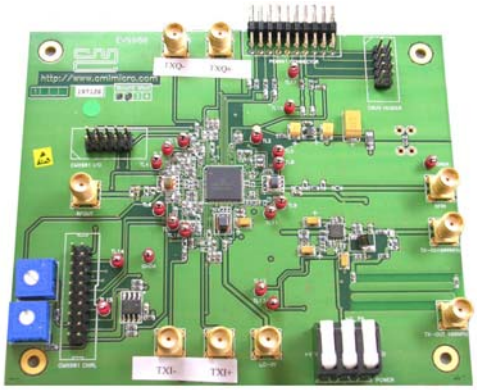
COMMUNICATION SEMICONDUCTORS

EV9980
Evaluation Kit User Manual

UM9980/2 August 2006 Provisional Issue

Features

- Allows full evaluation and investigation of the CMX998 Cartesian Feedback Transmitter IC
- Operational range: 100MHz to 1GHz by use of on-board matching components
- Access to RF, control and baseband signals via connectors and test points
- Complete demonstration of the CFBL functionality: default is 400MHz and configurable for 800MHz
- Support and interfacing for customer PAs
- Interfaces to CMX981 EvKit
- Differential or single-ended I and Q inputs
- Can utilise PE0001 EvKit interface card for PC interface or work with custom interface equipment



1. Brief Description

The EV9980 EvKit allows rapid and full evaluation of the CMX998 Cartesian Feedback Transmitter IC.

In the form of a populated PCB, this flexible platform enables users, using a control interface, to configure and evaluate the CMX998 to various applications and frequency bands.

Access is provided to all CMX998 RF, baseband and control signals by either connector or test points. Test access points are available to accept common test equipments such as RF and baseband signal generators and spectrum analysers.

All signal paths are matched by suitable components and the EvKit provides, on-board, two power amplifier devices, one at 400MHz (default) and one at 800MHz; support is also available for the connection and operation of a custom PA. The overall operating evaluation frequency range of the EvKit is for RF frequencies between 100MHz and 1GHz.

The EV9980 can be configured to work with the CMX981 Digital Radio Baseband processor IC or with a custom baseband system.

No software is required for use of the EvKit; the on-board CMX998 is controlled via its C-BUS serial interface and control system. An evaluation interface is supplied separately that uses the CML PE0001 EvKit Interface Card and is controlled via the EV9980 PC software. Also a custom C-BUS interface and control system can be used.

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It is always recommended that you check for the latest product datasheet version from the Datasheets page of the CML website: [www.cmlmicro.com].

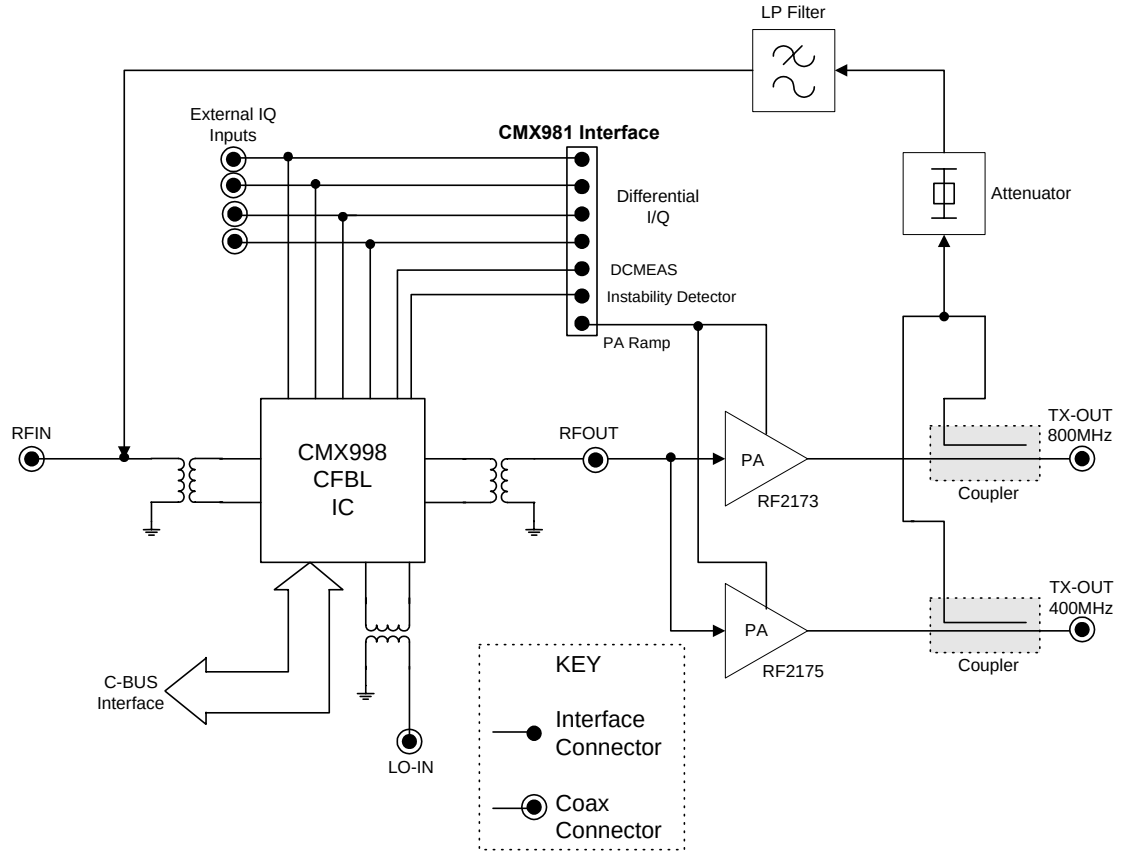

Figure 1 – Block Diagram

2. Preliminary Information

The EV9980 provides a platform for the evaluation of the CMX998. To use the EV9980, a separate micro-controller or PC, for example, is required to program the CMX998 via its C-BUS interface. This controlling device is not included on the EV9980 but there is a CML product available to provide the controlling functionality: the PE0001 with EV9980 PC software (ES9980xx.exe).

2.1. Laboratory Equipment

The following laboratory equipment is needed to use this evaluation kit:

- Dual Power Supply
- Spectrum Analyzer (100MHz to 1GHz)
- RF Attenuator
- RF Signal Generator (100MHz to 2GHz)
- I/Q Signal Source

For more detailed design or investigation work the customer may require other RF test equipment.

2.1.1. Power Supply

The supply input voltage to the PCB, for all circuits except the PA, is 7.2V (5.25V to 8V acceptable). On board regulators are provided to generate all voltage rails used on the PCB (3.3V and 5V rails are used).

The supply to the PA is directly connected to the PA: a voltage of 3.6V, at the PA, is recommended. (See also section 6.5.1)

The 7.2V supply should be rated at 1A and the 3.6V supply rated at 2A.

NOTE: Care should be exercised with the supplies, as they are not protected for reverse polarity. For optimum RF performance, the PA supply is connected directly to the RF2173 and RF2175 device so care is required to ensure the RF2173 and RF2175 manufacturer's ratings are not exceeded.

2.2. Handling Precautions

Like most evaluation kits, this product is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

2.2.1. Static Protection

This product uses low power CMOS circuits that can be damaged by electrostatic discharge. Partially damaged circuits can function erroneously, leading to misleading results. Observe ESD precautions at all times when handling this product.

2.2.2. Contents - Unpacking

Please ensure that you have received all of the items on the separate information sheet (EK9980) and notify CML within 7 working days if the delivery is incomplete.

2.3. Approvals

This product is not approved to any EMC or other regulatory standard. Users are advised to observe local statutory requirements, which may apply to this product and the radio frequency signals that may emanate from it.

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3. Quick Start

This section provides instructions for users who wish to experiment immediately with the evaluation kit. A more complete description of the kit and its use appears later in this document. The EV9980 includes a CMX998 device that is described in its own, separate, datasheet. Accordingly, the user should read the current CMX998 datasheet before using the EV9980.

3.1. Setting-Up

The following procedure is recommended:

1. Connect test leads as shown below in Figure 2.
2. Connect a host µController to C-BUS interface J13 or J15 (alternatively the CML PE0001 card and ES9980xx.exe software can be used – see section 6.3).
3. The power amplifier output (J9) should be connected to a suitable 50Ω load. The default frequency of operation for the EV9980 is 400MHz.
   The use of an external 50Ω Load is essential to prevent possible damage to the PA stage.
4. Power should be applied to the main supply (7.2V nominal).
5. A connection should be made to J12 pin 15 to allow the PA control volts to be adjusted
6. Power should be applied to the power amplifier supply connector (3.6V).

The board is now ready for operation.

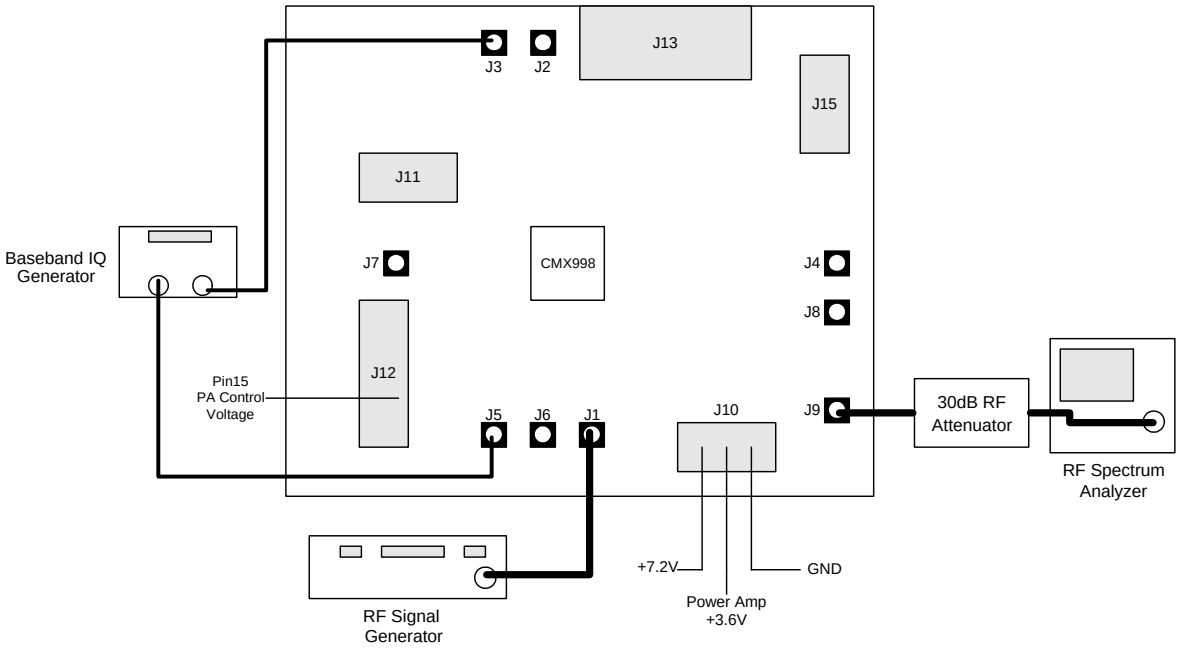

Figure 2 – Typical Evaluation Connections for EV9980

3.2. Input Conditions

LO Input (J1) should be at 800MHz at –10dBm. No baseband I and Q signals (J5 and J3) should be applied at this time only a 0VDC bias input is required. For reference: the nominal I and Q input is an AC input signal level of ~500mVp-p at 0VDC bias.

3.3. Operation

It is recommended that the user familiarise themselves with the IC datasheet and the EV9980 user manual prior to attempting to use the EV9980.

To use the EV9980 the user will need a mechanism to control the CMX998 via its C-BUS interface, which is brought out on connector J13 (J15 can also be used) on the EV9980. The CMX998 datasheet gives details of the registers and commands. To operate the CMX998, a typical general register setup is given below:

- Initially no IQ signals should be applied.
- The general control register should be configured such that the bias circuits, filter amplifiers, input amplifiers, error amplifiers, forward path and feedback path are all enabled. Bits 0 and 1 of the general control register should be in their normal operation state i.e. b0/b1 = 0.
- A typical setting for the phase control register would be 22.5degs.
- Typical setting for the forward and feedback path attenuator would be 0dB and 13dB respectively (this configuration gives full output power at 400MHz).
- The frequency control register should be set for divide by 2 mode (this means that a LO input has to be applied at twice the operating frequency).
- To achieve the nominal output power from the PA a control voltage of 1.1VDC needs to be applied to pin 15 of J12.
- The output should be analysed to ensure loop phase is set correctly.
- The level of the carrier signal needs to be adjusted for a minimum by use of VR1 and VR2.
- Baseband IQ signals can now be applied to achieve the nominal output power level of ~+29dBm (average power).

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4. Signal Lists

CONNECTOR PINOUT				
Connector Ref.	**Connector Pin No.**	**Signal Name**	**Signal Type**	**Description**
J1	N/A	LO-IN	RF	LO input can be applied at 2 x RF output frequency or 4 x RF output frequency. Nominal input level is -10dBm.
J2	N/A	TXQ+	Baseband	Q input signal (non-inverting input of input amplifier)
J3	N/A	TXQ-	Baseband	Q input signal (inverting input of input amplifier)
J4	N/A	RFIN	RF	RF input to feedback path
J5	N/A	TXI-	Baseband	I input signal (inverting input of input amplifier)
J6	N/A	TXI+	Baseband	I input signal (non-inverting input of input amplifier)
J7	N/A	RFOUT	RF	Upconverter RF output
J8	N/A	TX-OUT 800MHz	RF	800MHz PA output
J9	N/A	TX-OUT 400MHz	RF	400MHz PA output
J10	3	+7.2V	DC	7.2V power supply input
J10	2	+3.6V	DC	3.6V power supply for RF power amplifier
J10	1	GND	DC	Power supply ground
J11	1, 3, 7, 9	TXQ+, TXQ-TXI-, TXI+	Baseband	Differential I/Q input from the CMX981 evaluation board
J11	2, 4, 5, 6, 8, 10	GNDA	Baseband	Connection to Analogue Ground
J12	1	INSTAB	Baseband	Instability detector output to CMX981 connector
J12	3	DCMEAS	Baseband	DCMEAS output to CMX981 connector
J12	5	FW_Q	Baseband	Forward path baseband Q signal to CMX981 connector
J12	7	FB_Q	Baseband	Feedback path baseband Q signal to CMX981 connector
J12	9	FB_I	Baseband	Feedback path baseband I signal to CMX981 connector
J12	11	FW_I	Baseband	Forward path baseband I signal to CMX981 connector
J12	15	PA_CNTRL	DC	PA control voltage external or from CMX981 evaluation board

CONNECTOR PINOUT				
Connector Ref.	**Connector Pin No.**	**Signal Name**	**Signal Type**	**Description**
J13	1 - 20	C-BUS Interface	Logic	C-BUS interface from PE0001 or host / controller PC. See schematics and CMX998 datasheet for details.
J15	1 - 10	Alternative C-BUS Interface	Logic	Alternative header for C-BUS interface

Table 1 – Signal List

CONNECTOR PINOUT for J13			
Connector Pin No.	**Signal Name**	**Signal Type**	**Description**
1	RESET	I/P	General RESET (RESET active low)
2	CSN	I/P	C-BUS Enable
3	~	~	Spare pin. Leave unconnected.
4	S_DATA_IN	I/P	C-BUS Data Input
5	~	~	Spare pin. Leave unconnected.
6	S_CLOCK	I/P	C-BUS Clock
7	~	~	Spare pin. Leave unconnected.
8	S_DATA_OUT	O/P	C-BUS Data Output
9	~	~	Spare pin. Leave unconnected.
10	IRQN	I/P	Interrupt request - if required. Not used.
11	GNDD	Power	Connection to Digital Ground
12	GNDD	Power	Connection to Digital Ground
13	~	~	Spare pin. Leave unconnected.
14	~	~	Spare pin. Leave unconnected.
15	~	~	Spare pin. Leave unconnected.
16	~	~	Spare pin. Leave unconnected.
17	~	~	Spare pin. Leave unconnected.
18	~	~	Spare pin. Leave unconnected.
19	~	~	Spare pin. Leave unconnected.
20	~	~	Spare pin. Leave unconnected.

Table 2 – PE0001 Interface

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TEST LOOPS		
Test Loop Ref.	**Default Measurement**	**Description**
TL1		Q Input Amplifier Output
TL2		Instability Detector Output
TL3		Q Image Filter Amplifier Output
TL4		Q Error Amplifier Output
TL5	1.6VDC	BVREF Buffered Vref
TL6		I Error Amplifier Output
TL7		I Image Filter Amplifier Output
TL8		Demodulator Output (Q channel)
TL9		Demodulator Output (I channel)
TL10		I Input Amplifier Output
TL11		Connection point for AVdd on CMX981 evaluation board
TL12		800MHz power amplifier control voltage
TL13		400MHz power amplifier control voltage
TL14		DCMEAS Output
TL15		Spare connection on J12:J13
TL16		C-BUS Data Output
TL17		IRQN (not used)
TL18		GND probe point
TL19		GND probe point

Table 3 – Test Loops

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TEST POINTS		
Test Point Ref.	**Default Measurement**	**Description**
TP1	3.3V	3.3V regulator output for digital circuits
TP2	3.3V	3.3V regulator output for analogue circuits
TP3	5.0V	5.0V regulator output for RF circuits
TP7	0V	Digital Ground
TP8	0V	Digital Ground
TP9	0V	Analogue Ground
TP10	0V	Analogue Ground

Table 4 – Test Points

Notes:

I/P	=	Input
O/P	=	Output
BI	=	Bidirectional
TL	=	Test Loop
TP	=	Test Point

5. Circuit Schematics and Board Layouts

For clarity, circuit schematics are available as separate high-resolution files. These can be obtained via the CML website.

The following changes apply to the EV9980 PCB (PCB555B) Mod. State 2, when referring to schematic (DWG9980B04.pdf). These changes have already been made to the Evaluation Kit.

No	Circuit Area and Component Reference	Comment	Change
1	+V power line C109, C133, J10	Cure coupling between 400MHz PA and power supply which caused degraded adjacent channel power.	Cut +V track on the top layer of the board close to C109 Place a wire link on bottom layer between J10 pin 3 and C133

The layout on each side of the pcb is shown in *Figure 3* and *Figure 4*, below:

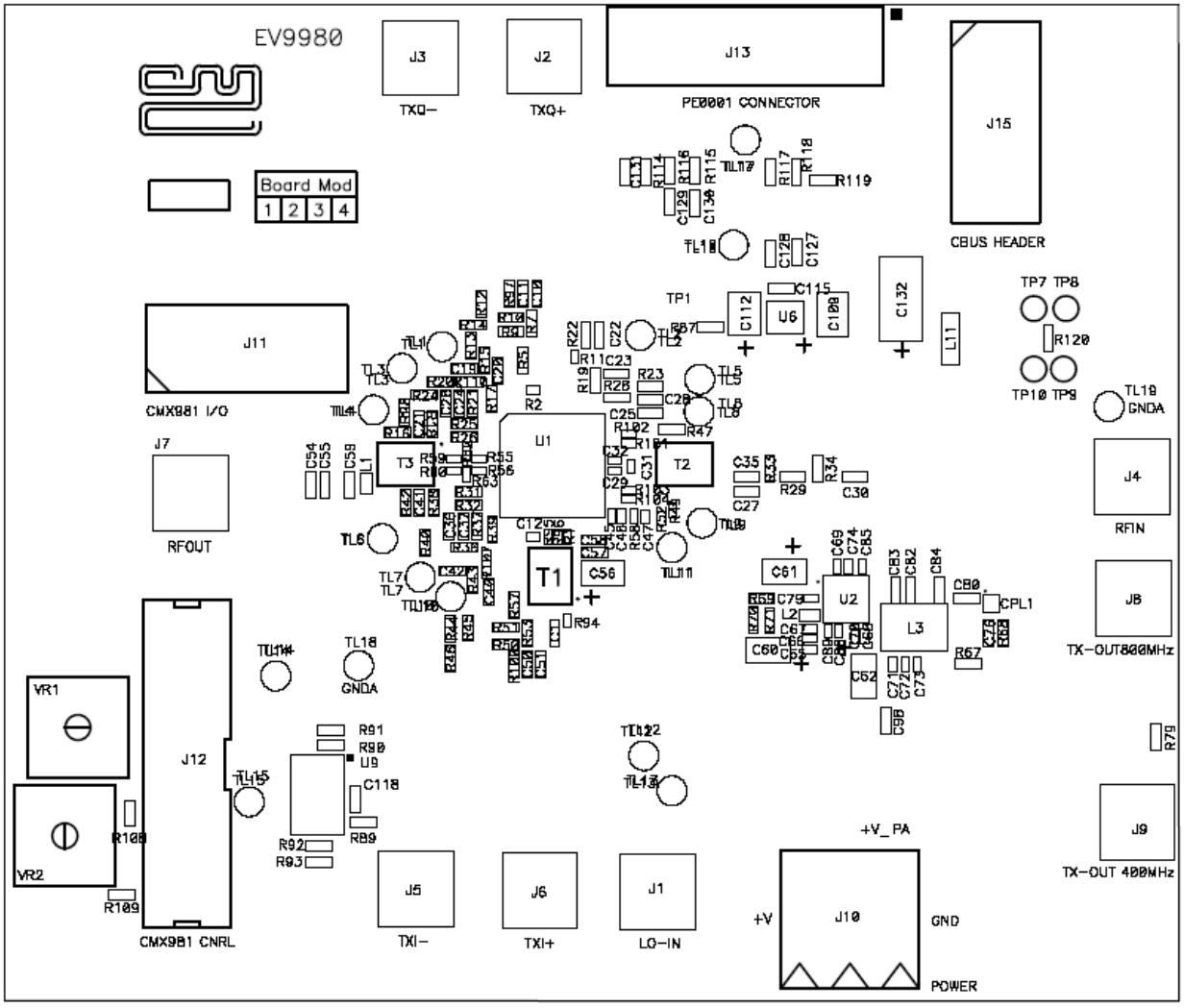

Figure 3 – PCB Layout: top

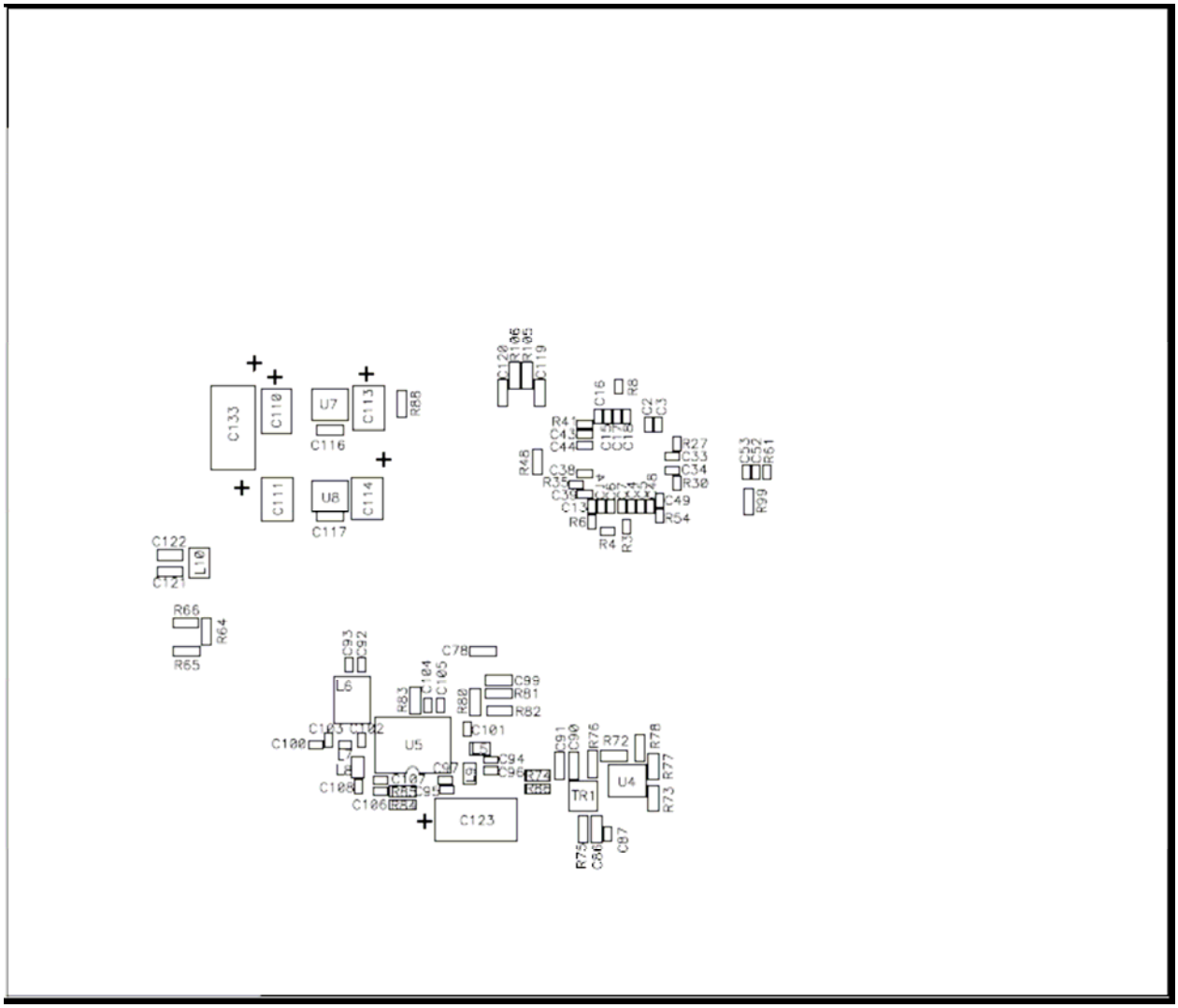

Figure 4 – PCB Layout: bottom

6. Detailed Description

The CMX998 datasheet (not included, but available at www.cmlmicro.com) should be referred to for a detailed description of the CMX998 device.

The EV9980 functionality includes:

- Demonstration of the CFBL RF functionality, PA devices have been included to allow operation at 400MHz and 800MHz to be evaluated in detail.
- Operation at 100MHz to 1000MHz.
- Support for customer power amplifiers at different powers and frequencies over the full operating range of the CFBL IC.
- C-BUS Interface that allows the card to be connected to a host µController. Interface to a PC for initial test and customer evaluation is available separately with suitable PC software that allows control of all device functions.
- Interface directly to CMX981 evaluation card allows demonstration of:
    - o π/4-DQPSK modulation
    - o burst and continuous transmission

In summary, the EV9980 allows the user to create experiments to investigate all aspects of the CMX998 device. The EV9980 is designed to allow user modification, to support detailed investigation of each user's specific and different applications.

6.1. Hardware Description

6.1.1. Cartesian Feedback Loop (CFBL)

The card is configured to allow the CFBL to operate in normal operation with single ended external inputs. The gains are set in the baseband amplifier sections to suit the input drive levels in section 6.1.4. The error amplifier is configured with a loop filter optimised for operation with the on-board power amplifiers but can be configured with user values for any other requirements. It is possible to access the up-converter output and the down-converter input so that customers can connect their own power amplifiers into the loop. The LO input, up-converter output and the down-converter input are all matched with broadband balun/transformer to allow wideband operation from 100MHz to 1GHz.

The RESET pin (active low) is pulled high with 100k ohms. The user can pull this pin low to reset the device (or the software reset can be used).

6.1.2. Power Amplifiers

The card includes power amplifiers to demonstrate the CFBL IC at ~400MHz or ~800MHz. The 400MHz amplifier (default connection) is capable of producing 29~30dBm (mean) with pulsed π/4-DQPSK modulation. An option of using a 800MHz power amplifier is included in the design and this is also capable of 30dBm (mean) output with π/4-DQPSK modulation. Component changes are required to make use of this option, see section 6.2.1.

Gain control has been included which allows the power amplifiers to be connected to the CMX981 Ramping DAC or to an external variable voltage source.

6.1.3. Local Oscillator (LO)

The local oscillator has not been provided on the EV9980. A connector is provided to allow an external oscillator source to be injected at twice or four times the RF output frequency depending on the oscillator mode selected.

6.1.4. IQ Baseband Inputs

The board allows the IQ inputs to come from the CMX981 or from an alternative external source. The input can be differential or single ended. Adjusting the values around the CMX998 input amplifiers creates the required input configuration. The default setup is for single ended inputs, which are applied to TXI- and TXQ-. A typical input signal would be ~500mVp-p at 0VDC bias.

6.1.5. CMX981 Interface

The EV9980 has an interface to allow connection to the CMX981 Evaluation card. There are two connectors J11 and J12 that include the following signals:

- I/Q Input signals from CMX981
- DCMEAS pin from CMX998 to CMX981 AUX ADC
- Ramping DAC signal from CMX981 to EV9980 power amplifiers
- Instability detector output
- DC Nulling signal input (optional)

6.1.6. Manual DC Nulling

The DC nulling can be done manually through the use of VR1 and VR2 variable resistors. They affect the DC level of at the input to the modulator so that the carrier can be nulled to a minimum manually. Automatic control has been implemented through the CMX981 interface.

6.1.7. Power Supply

The input to the PCB for CMX998 and interface circuits is nominally 7.2V (5.25V to 8V is acceptable). On board regulators are provided to generate voltage rails used on the EV9980 (3.3V used for CFBL IC).

The power supply to the PA is directly from a separate 3.6V input.

6.2. Adjustments and Controls

The user has the ability to configure the EV9980 for a number of different operational scenarios.

6.2.1. 800MHz Operation

The default operating frequency is 400MHz, so the following components need to be changed to enable the EV9980 to work at 800MHz:

- C98, C99, R86 become not fitted (NF)
- C76, C78 should be 1nF
- R74 should be 0R
- L10 should be 0R
- C121, C122 should be not fitted (NF)

Typical values for CMX998 registers at 800MHz are:

- phase control register 67.50 degrees
- forward path attenuation = 0dB
- feedback path attenuation = 18dB

(Note: for 400MHz typical values see section 3.3)

6.3. Software Description

The EV9980 does not require any embedded firmware. The CML product PE0001, available separately, can be used with the EV9980 and the related PC software (ES9980xx.exe). The ES9980 application allows the user to interact with the EV9980 via an easy to use graphical interface. It consists of three tabs: each one representing a particular set of registers or a particular function of the CMX998.

To select a tab simply click on the corresponding name in the row at the top of the program window. Setting or clearing the check box associated with a bit of a register will cause that bit to be set or cleared when the register is next written to. If the 'Auto Write' check box is set a register will be written whenever a check box or list box associated with it is modified. This removes the need to click the 'Write' button associated with that register. The program can be closed at any time by clicking the 'Close' button or by pressing 'Alt' and 'C' keys simultaneously.

6.3.1. The CMX998 ($01-$06) Tab

The CMX998 ($01-$06) tab gives access to the general control register, gain control register, phase control register and general reset command, see Figure 5.

In the case of the gain and phase control register slide bars have been used to allow easy control during operation.

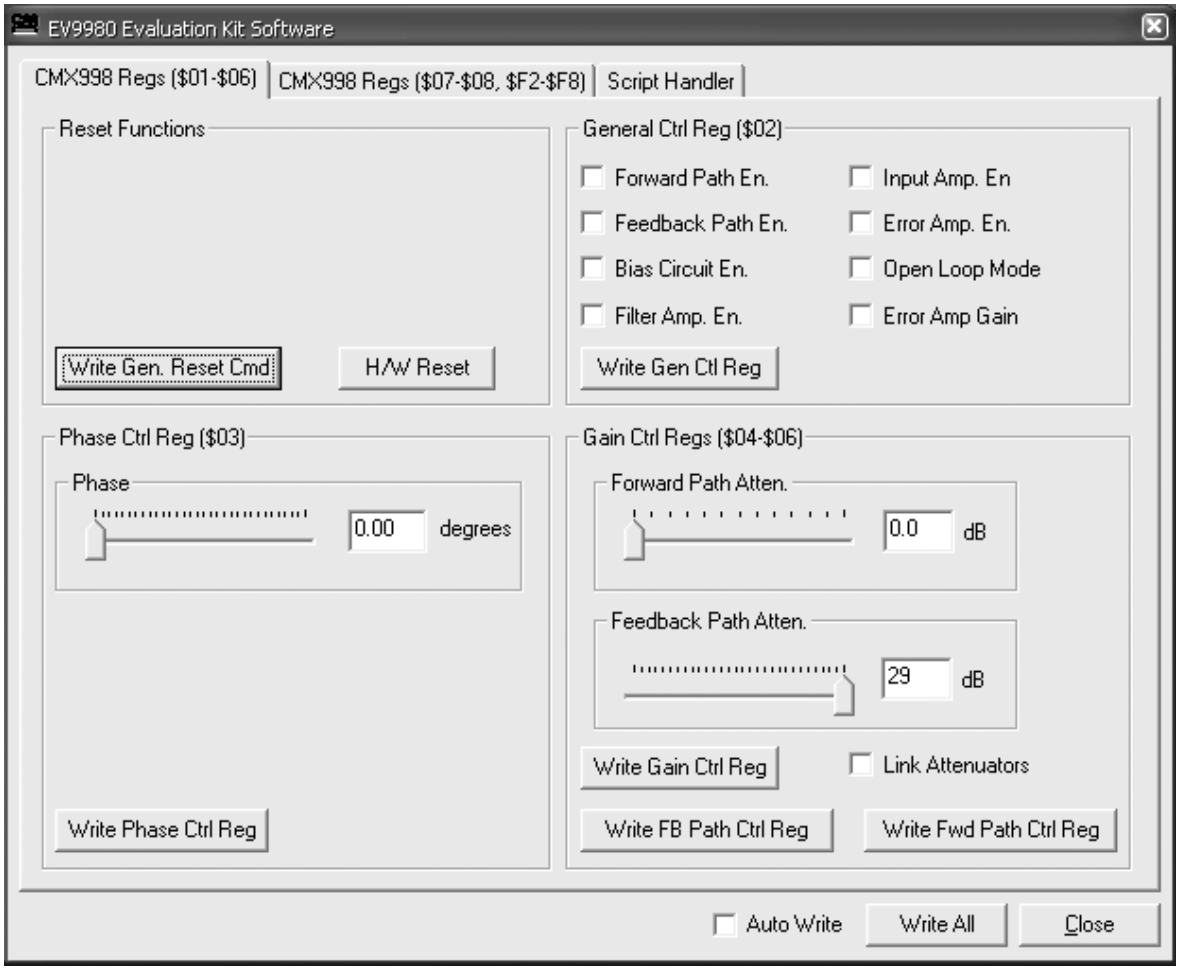

Figure 5 – The CMX998 ($01-$06) Tab

6.3.2. The CMX998 ($07-$08, $F2-$F8) Tab

The CMX998 ($07-$08, $F2-$F8) tab gives access to the aux control and frequency control registers, see Figure 6. This tab also allows the registers $F2 to $F8 to be read individually.

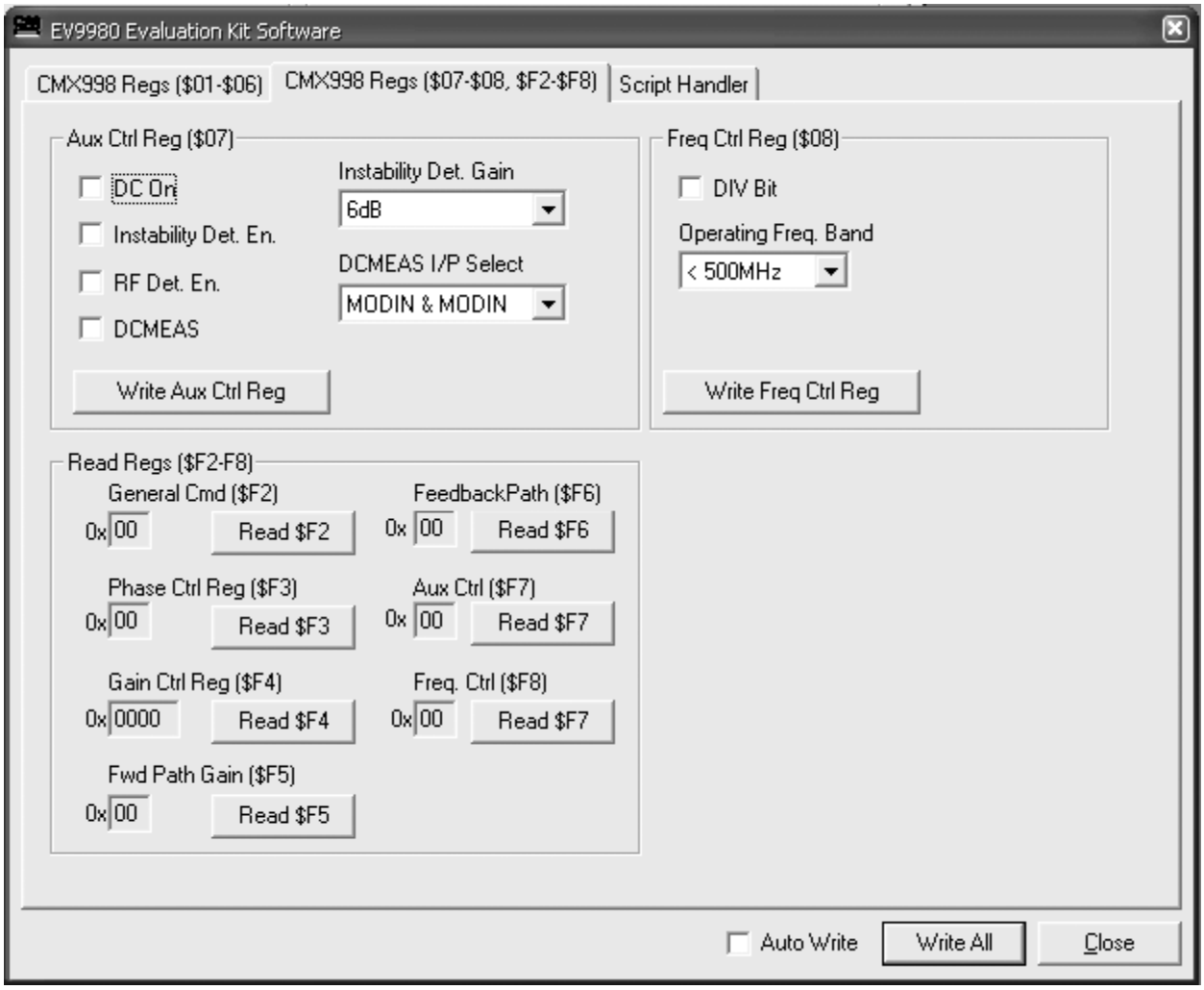

Figure 6 – The CMX998 ($07-$08, $F2-$F8) Tab

6.3.3. The Script Handler Tab

The Script Handler tab allows the execution of script files consisting of register write and read, delay commands, see Figure 7.

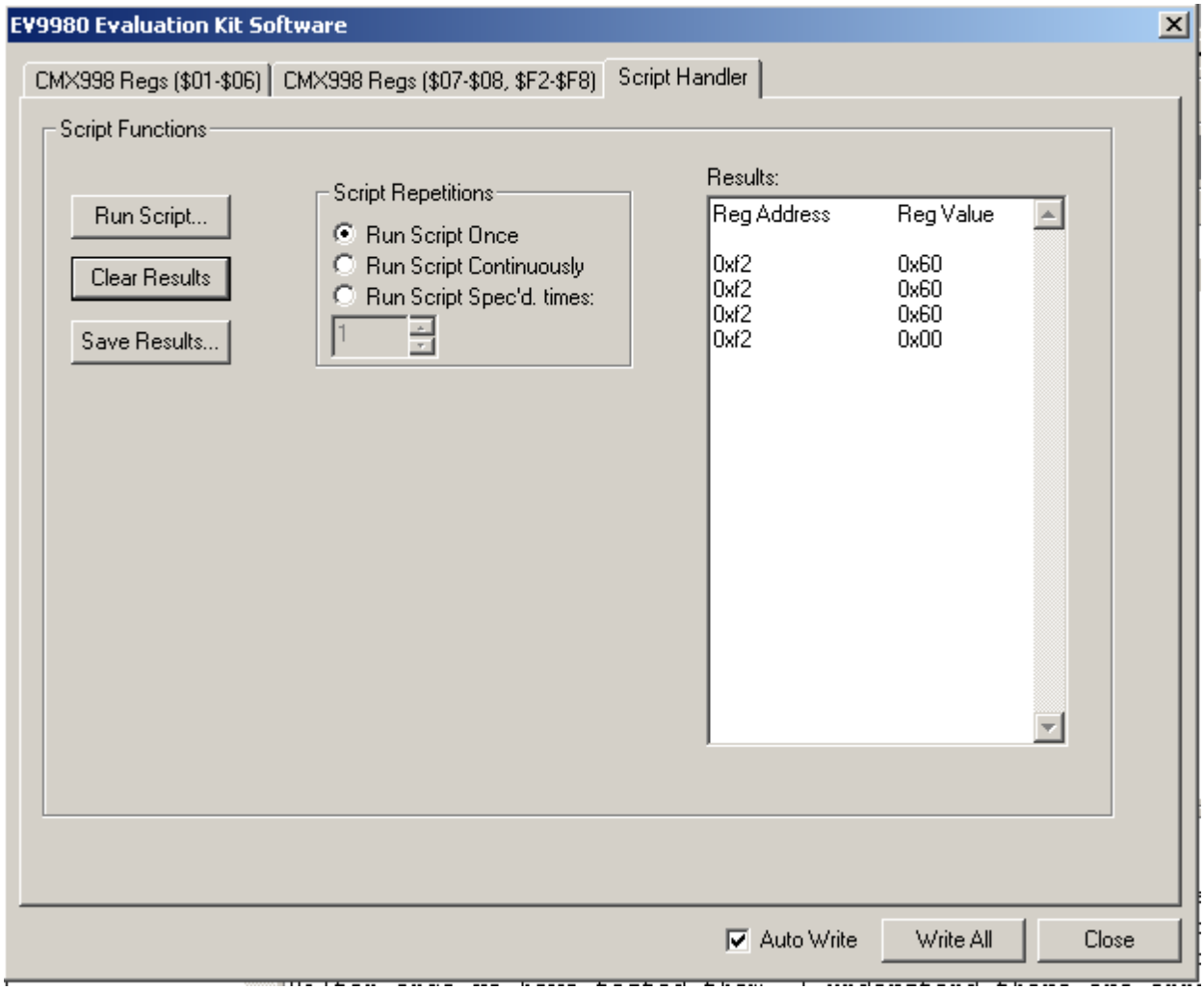

Figure 7 – The Script Handler Tab

The script files should be ASCII text files with each line containing one of following commands:

- Register write (8 bit) – WR8_*AA*_*DD*
- Register read (8 bit) – RD8_*AA*
- Register write (16 bit) – W16_*AA*_*DDDD*
- Register read (16 bit) – R16_*AA*
- Delay - DELAY_*X..X*
- Comment line - //*C..C*

Where *AA* is the 2 digit register address in hexadecimal, _ is a single space character, *DD* is the 2 digit register value in hexadecimal, *X..X* is a time to delay by in 10ms units and *C..C* is an ASCII string. The delay command stops any following script commands from being executed until the delay period has passed.

Each line must contain only one command and no other characters. An example script file is:

```
// Example Script File for EV9980
//
//
WR8 01 00
// send RESET
//
WR8 02 3F
//ENABLE VBIAS, Filter Pwr, Input Amp Pwr, Error Amp PWR, Open
Loop Mode, Error Amp Gain reduction
//
RD8 F2
// Read General Control Register
//
w16 04 0012
R16 F4
//  Set Forward gain=0dB, Feedback gain=-20dB; Read back Gain
Control Register
```

The results window will display the value returned by register read commands. These results can be saved to an ASCII text file or discarded by clicking on the 'Save Results' or 'Clear Results' buttons, respectively.

The ES9980 application will update the displayed register values to reflect those of any register read or write commands contained in an executed script file. When script file is being executed the other tabs cannot be selected. A script file can be executed once, repeatedly until the 'Stop' button is pressed or a specified number of times. The execution of a script file can be stopped or paused at any time by clicking the appropriate button.

6.4. Application Information

6.4.1. Error Configuration

The error amplifier configuration used on the EV9980 is shown in Figure 8. The following conditions apply to the values fitted on the EV9980, the 1st Pole is at ~16kHz, the 2nd Pole is at ~32kHz and the Zero is at ~320kHz. These can be changed for any user requirement.

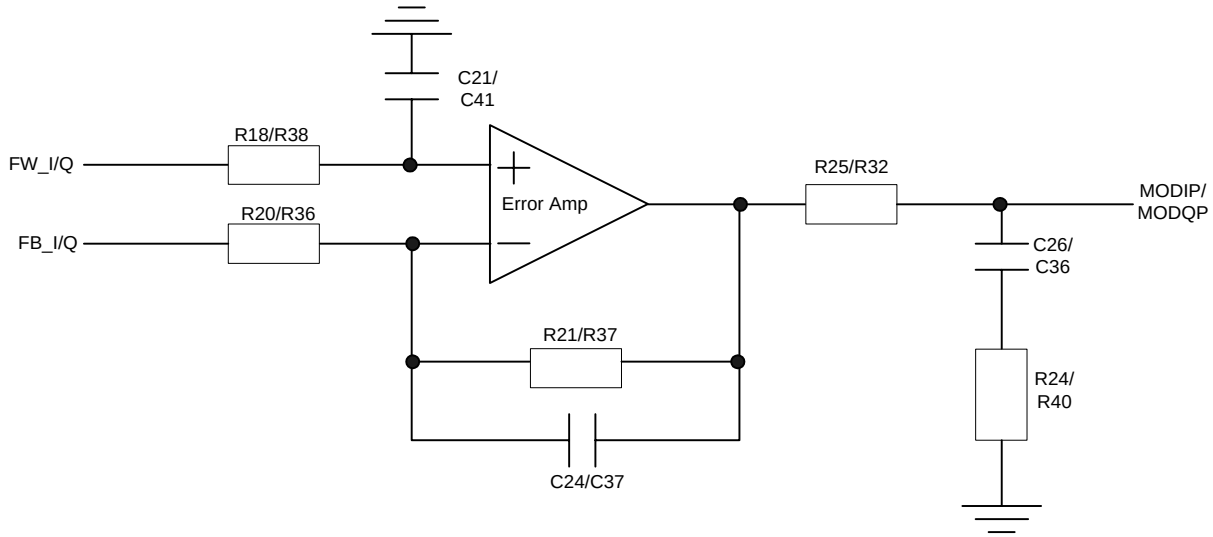

Figure 8 – Error Amplifier Configuration

6.4.2. Typical Performance of Closed Loop Configuration

The following plots show typical performance of the EV9980 with two-tone and 18ksymbols/s π/4DQPSK modulation.

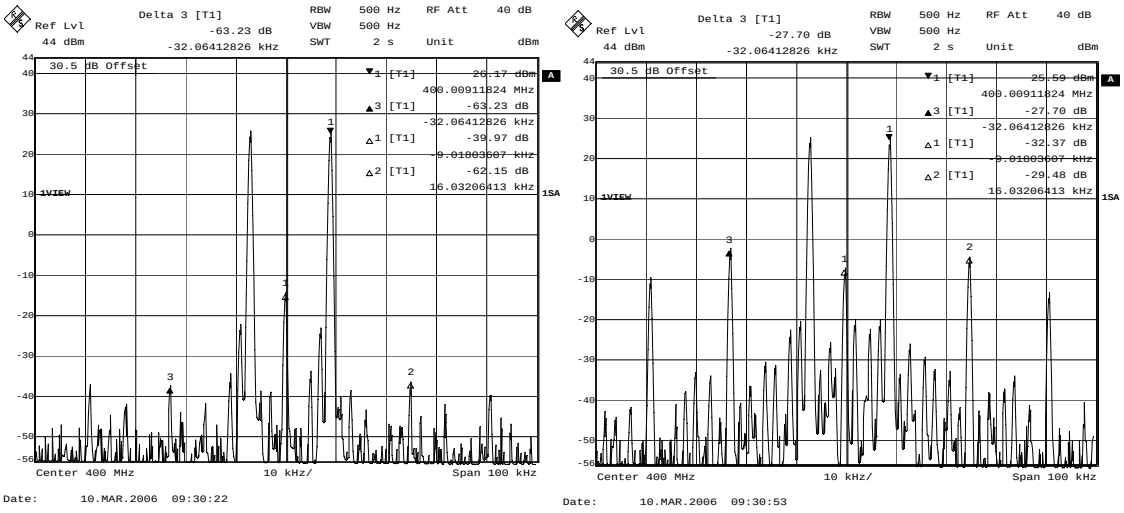

Figure 9 – CMX998 and RF2175 performance closed loop (left) and open loop (right) at approximately the same PEP output level, 400MHz

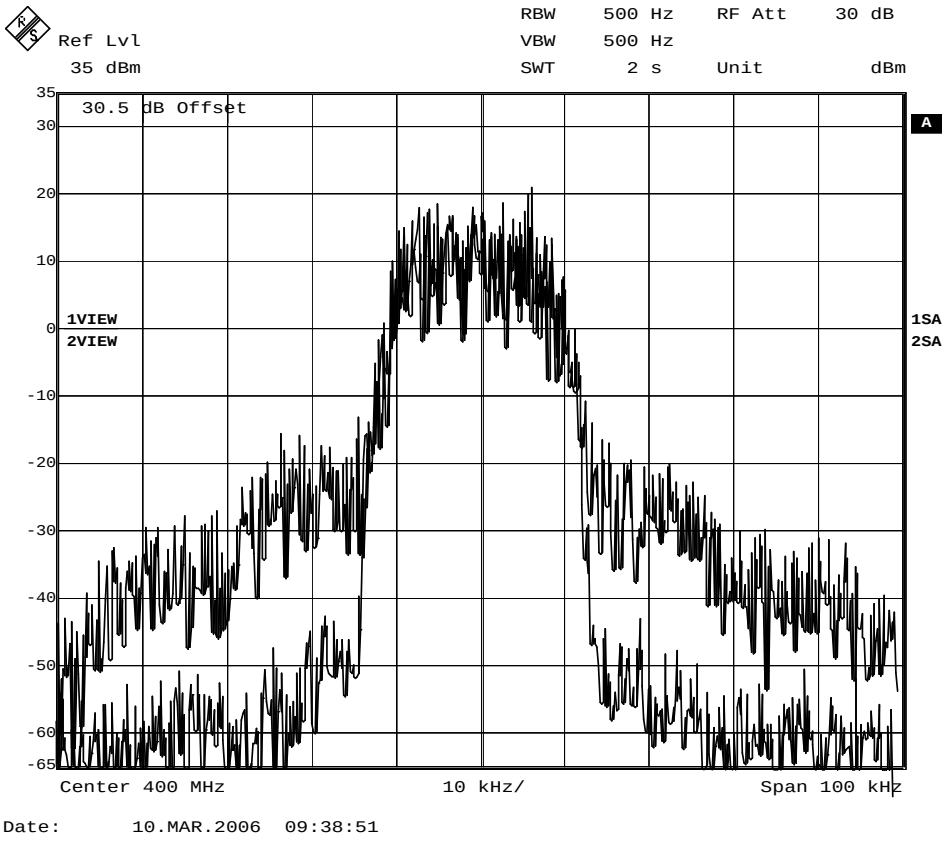

Figure 10 – CMX998 and RF2175 performance closed loop (lower) and open loop (upper) same PEP output level with 18ksymbols/s π/4DQPSK modulation, 400MHz

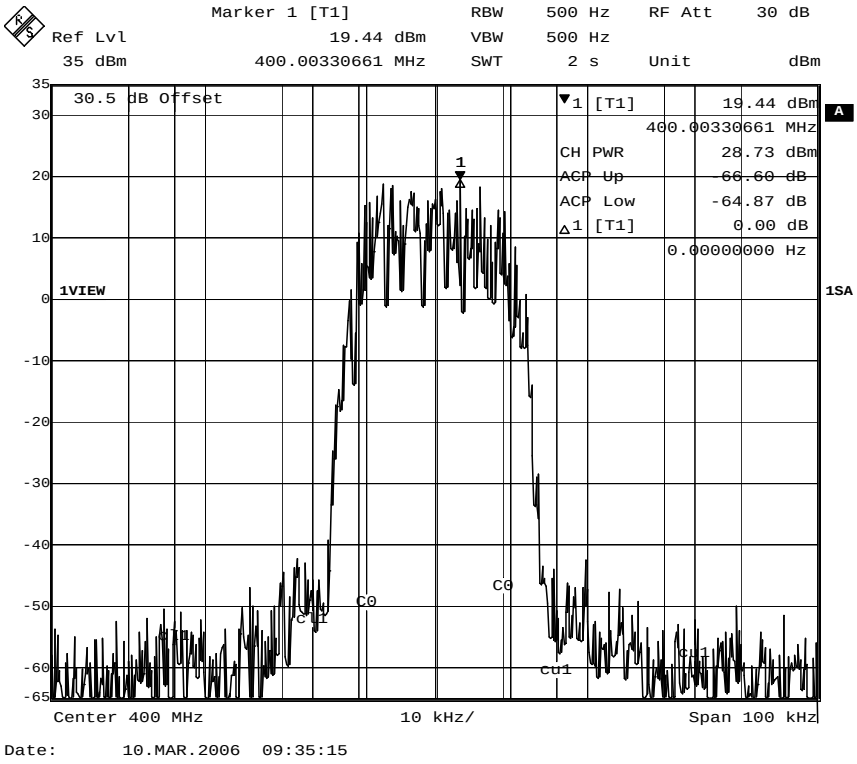

Figure 11 – CMX998 and RF2175 performance closed loop with 18ksymbols/s π/4DQPSK modulation, 400MHz

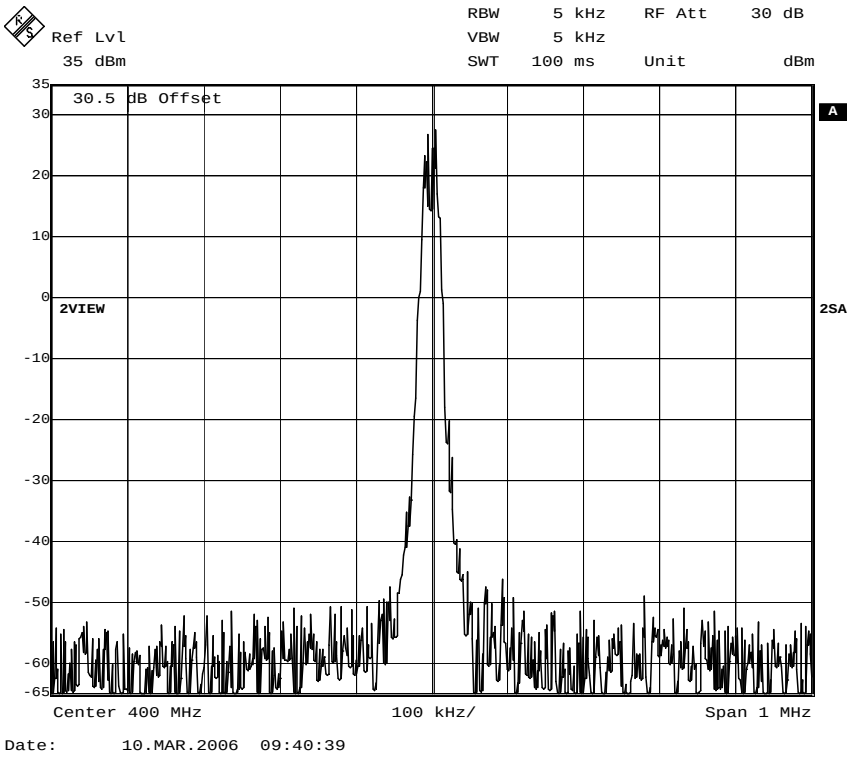

Figure 12 – Broadband (1MHz)plot of CMX998 and RF2175 performance closed loop with 18ksymbols/s π/4DQPSK modulation, 400MHz

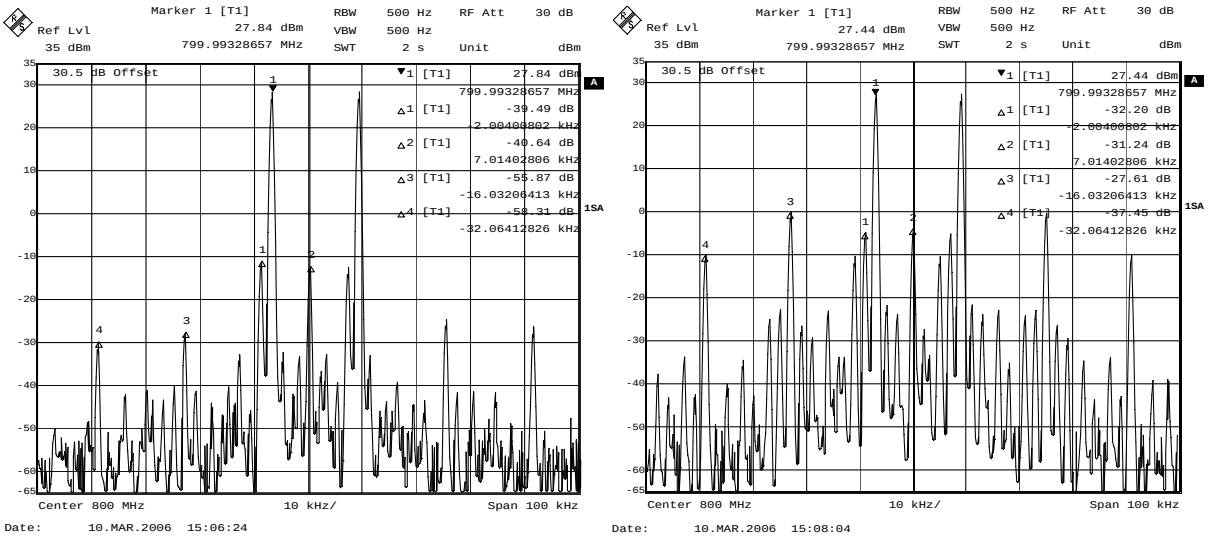

Figure 13 – CMX998 and RF2173 performance closed loop (left) and open loop (right) at approximately the same PEP output level, 800MHz

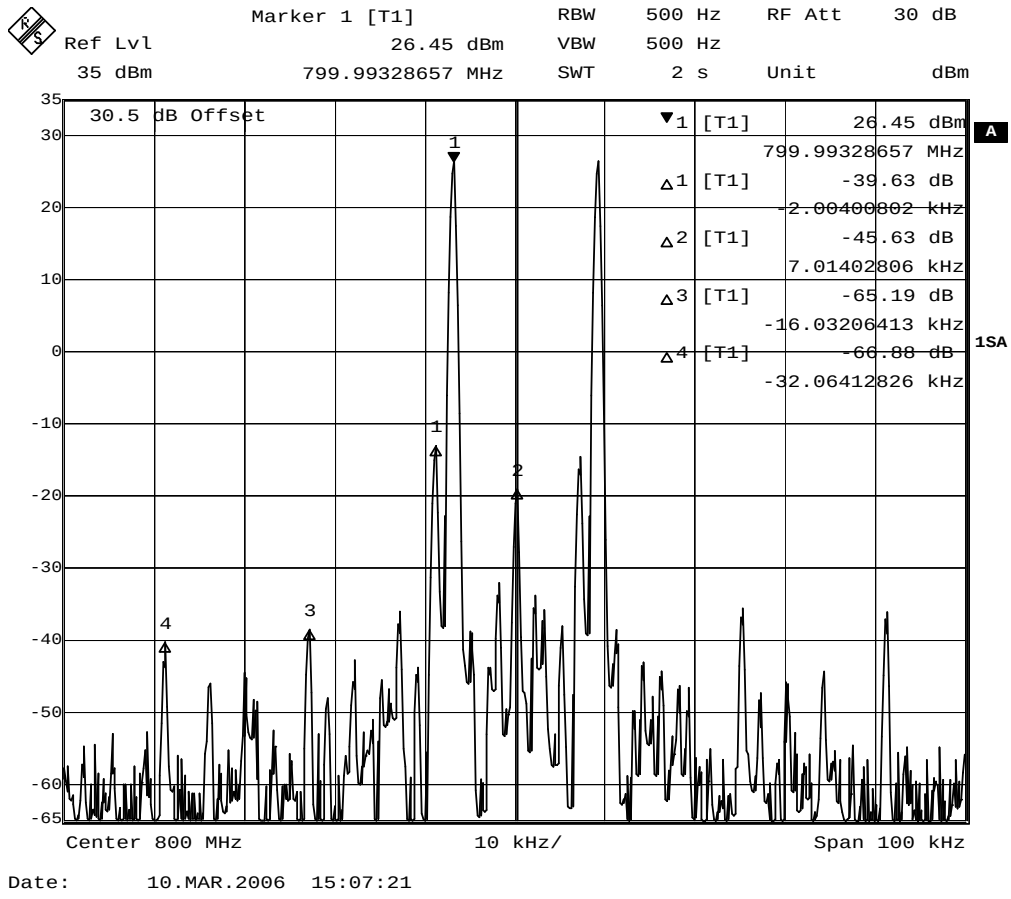

Figure 14 – CMX998 and RF2173 performance closed loop 18dB feedback path attenuation

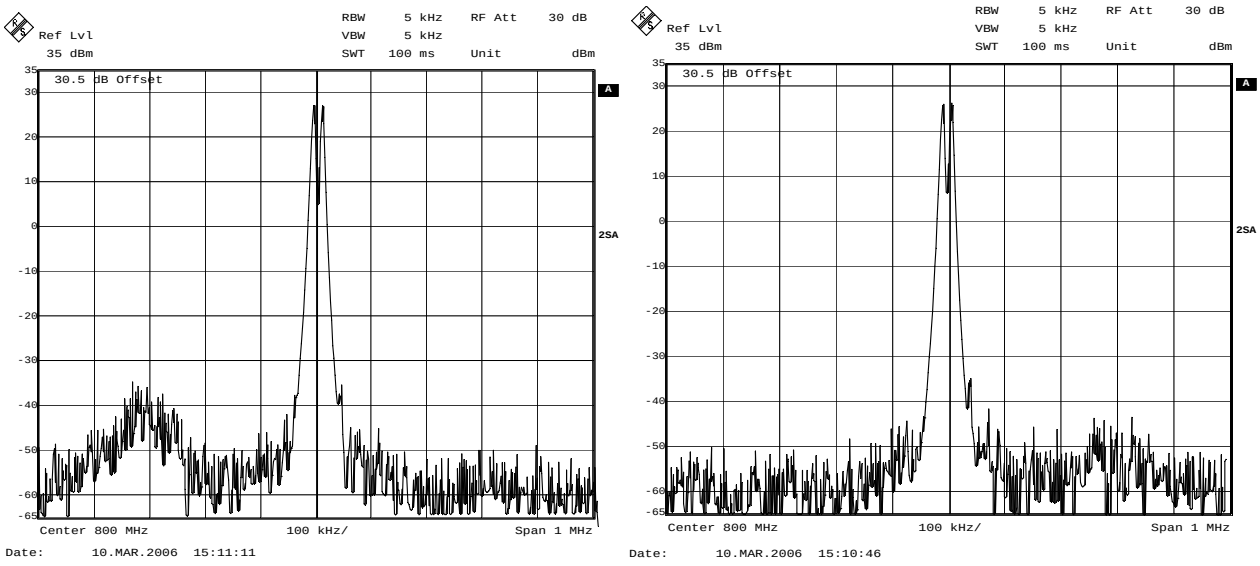

Figure 15 – CMX998 and RF2173 performance closed loop with phase control at extremes of stability = 11.25deg. (left) and 135deg. (right) showing classic peaking of noise when feedback phase is incorrect.

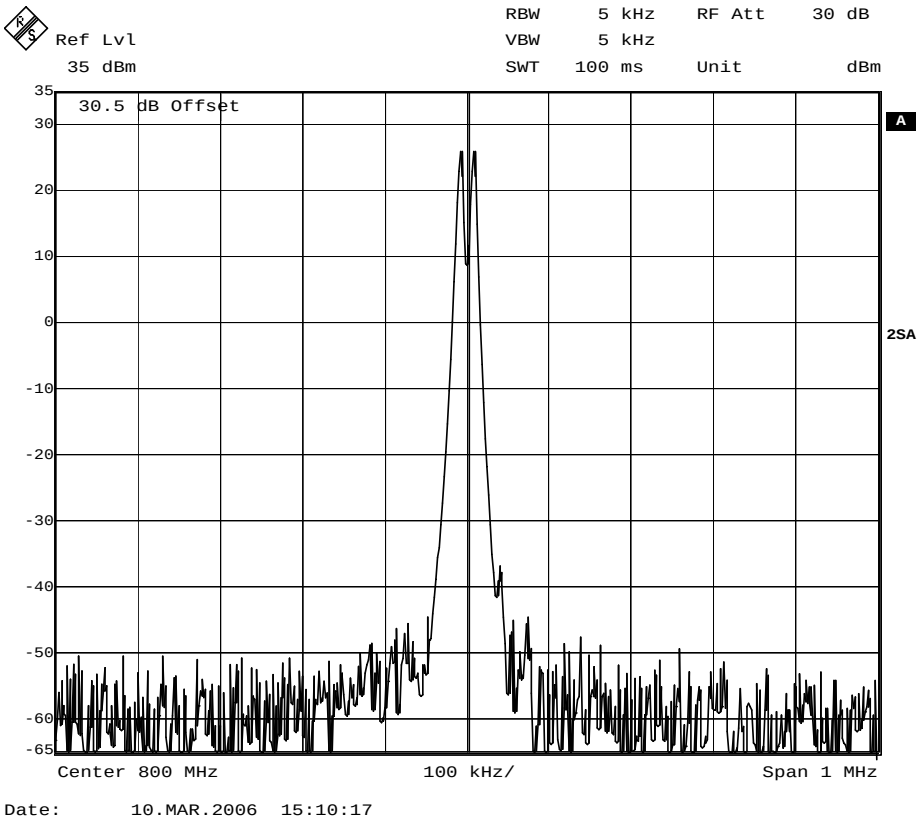

Figure 16 – CMX998 and RF2173 performance correctly adjusted closed loop with phase control of 67.50 deg. resulting in a clean spectrum

6.4.3. Testing the CMX998 with the CMX981

The EV9980 has an IQ interface to the EV9810 through the use of a 10-way header. The connections should be made, as follows:

EV9980 (J11)		EV9810 (J9)	
Label	**Pin No**	**Label**	**Pin No**
981_Q+	1	QTXP	10
981_Q-	3	QTXN	8
GNDA	5	GNDANALOG	6
981_I-	7	ITXN	4
981_I+	9	ITXP	2

Table 5 – EV9980 and EV9810 interconnection details

(Note: See also Figure 18).

The TX output of the CMX981 is differential I and Q, with a single ended signal level of 1Vp-p @1.28VDC. The CMX998 input amplifiers need to convert this differential signal into a single ended 1Vp-p @1.6VDC signal. A typical configuration for the input amplifiers on the 998 is shown in Figure 17.

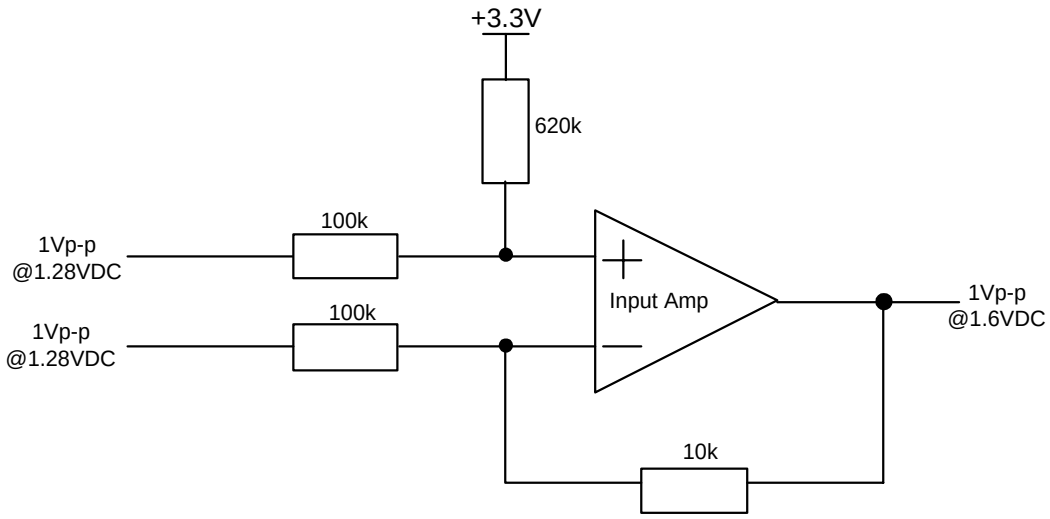

Figure 17 – CMX998 Input Amplifier Configuration

The results shown in this section were taken with the CMX998 configured as Figure 18. The component changes to the EV9980 to allow this configuration to work are:

Move C55 to C54
Move C27 to C30
Make C35 a 0R (0603 resistor)

To get ~0dBm after the splitter (splitter loss assumed to be ~3dB) the attenuator in the forward path = 0dB, the attenuator in the feedback path ~23-24dB. The optimal phase setting will vary between setups as it is determined by the length of leads used to complete the RF loop. On a 1MHz span on the spectrum analyser, check for noise humping to ensure correct phase has been set.

The plots in Figure 19, Figure 20, Figure 21, Figure 22 and Figure 23 show the ACP performance, an open and closed loop comparison, trellis diagram, constellation diagram and symbol/error table respectively.

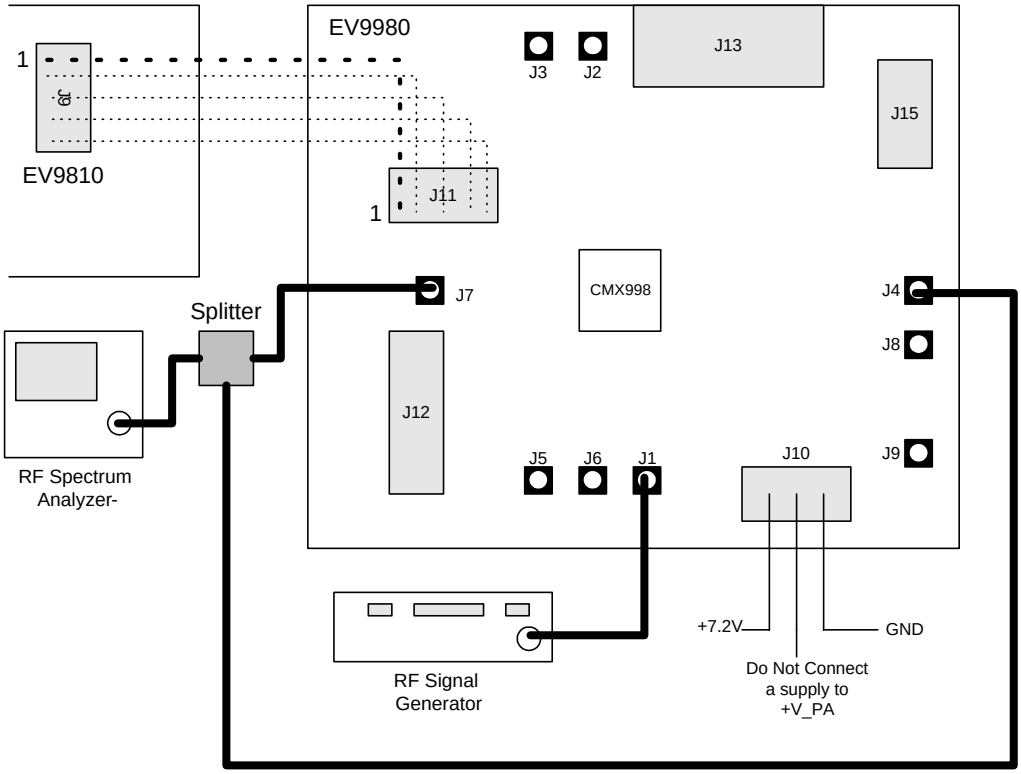

Figure 18 – CMX998 Configuration for testing with CMX981

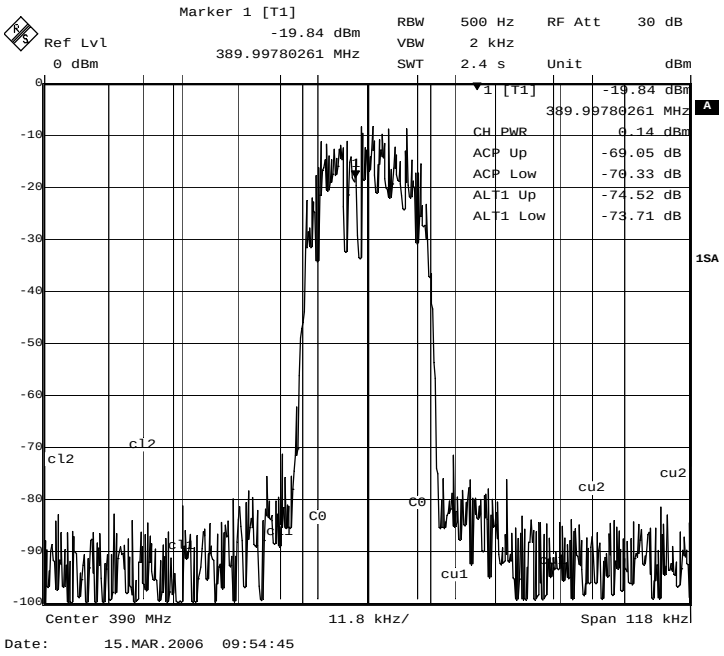

Figure 19 – 1st and 2nd ACP Performance

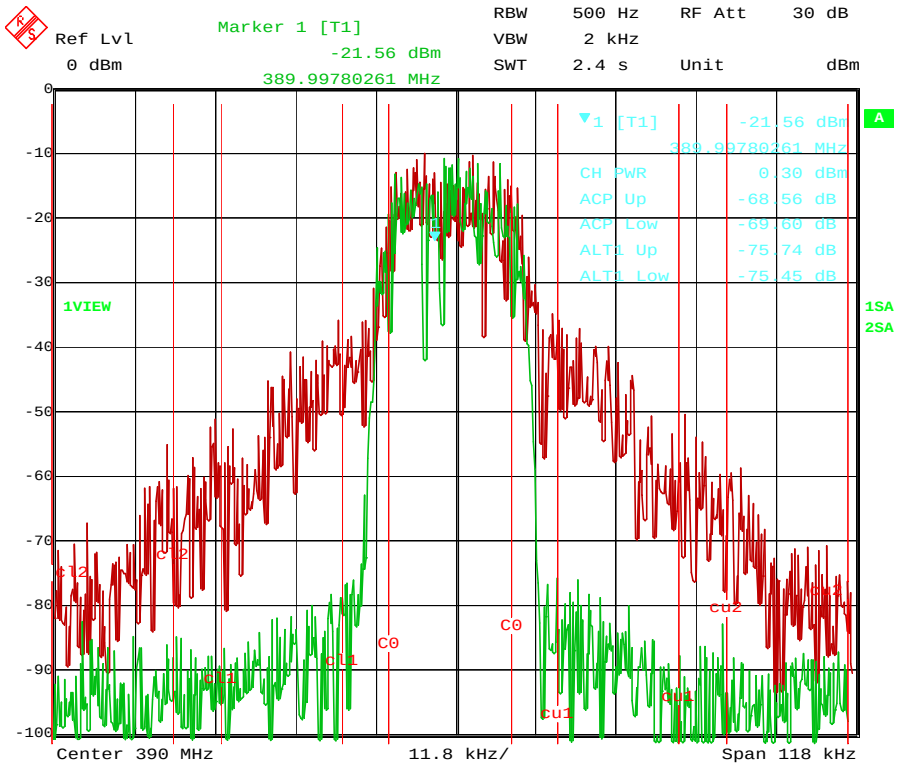

Figure 20 – Open and closed loop performance comparison

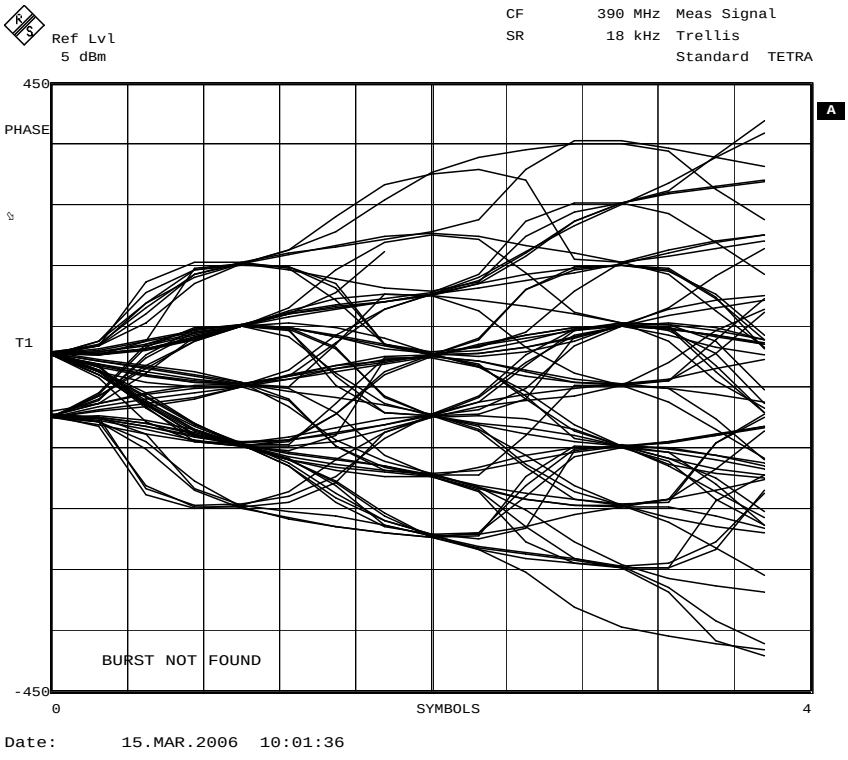

Figure 21 – Trellis Diagram

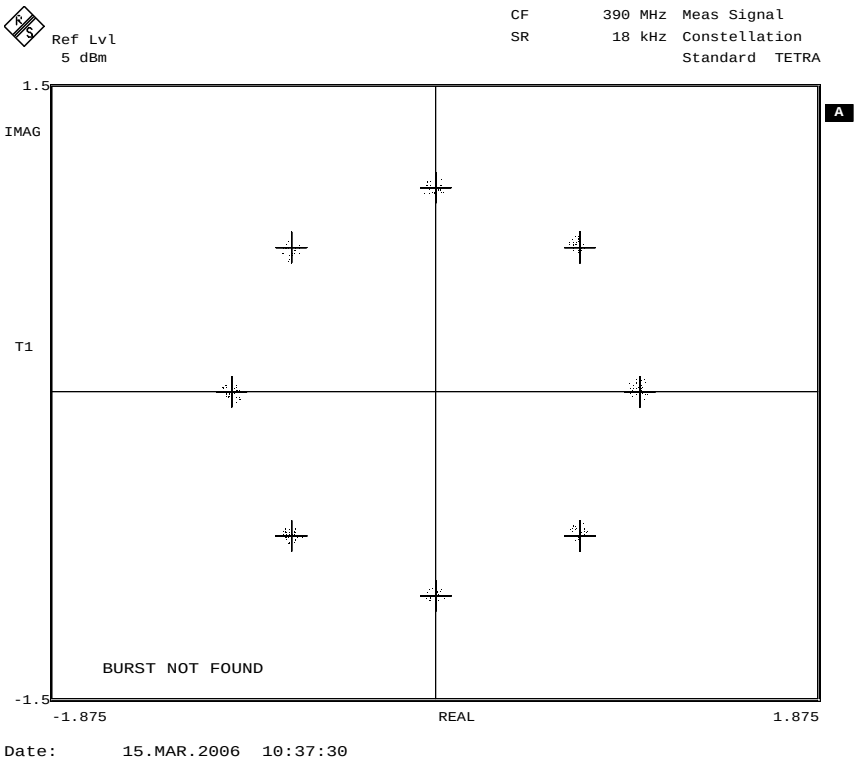

Figure 22 – Constellation Diagram

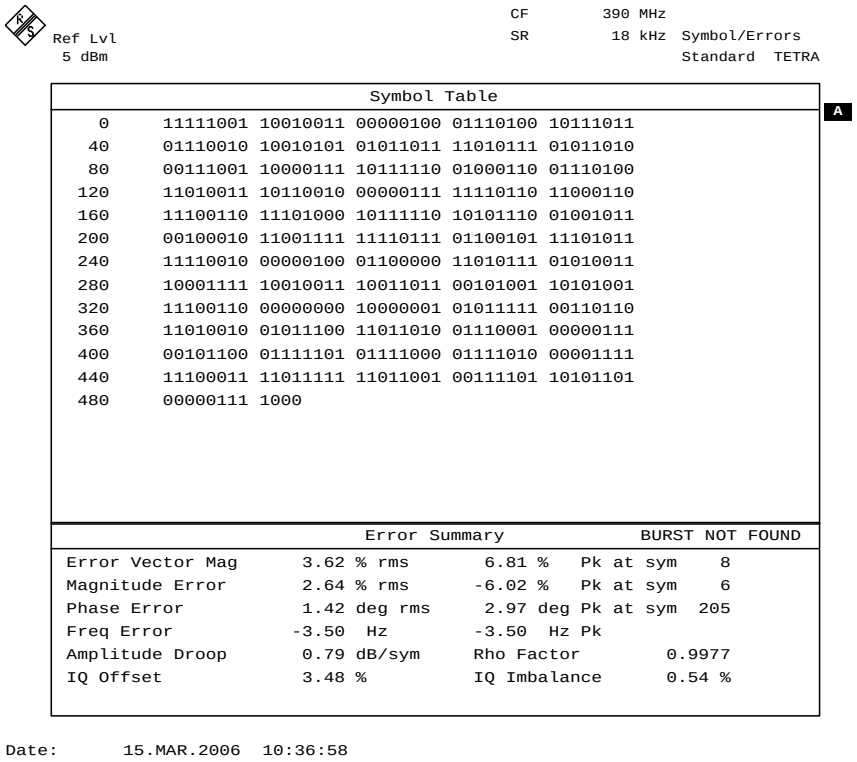

Figure 23 – Symbol/Error Table

6.5. Troubleshooting

The CMX998 is a complex RF system. If incorrectly programmed or modified, results will be at variance from datasheet performance. Please study the IC datasheet, this manual and the associated schematics and layout drawings carefully when troubleshooting.

This section provides some suggestions to help users resolve application issues they might encounter.

6.5.1. Closed Loop Operation

Error Observed	Possible Cause	Remedy
Instability, poor adjacent channel performance	Loop Phase is incorrect	Try adjusting the phase control register while analysing the RF output to see if spectrum improves
PA supply draws more 1.5A	Loop Phase incorrect	See above remedy above.
No RF Output	PA control volts are low, relevant circuitry not enable, or IQ signals not applied.	Check control volts at TL13 (or TL12) to see if voltage is close to +2.8VDC, try re-enabling circuitry in CMX998 or measure IQ signal at TL1.
No linearization of PA appears to be happening	Loop switch in wrong position, forward/reverse attenuator incorrectly set	Check state of loop switch, and adjust attenuator to see if spectrum improves.
No linearization of PA appears to be happening	Error amp gain reduction mode has been selected	
Discrete spurious present on transmission at 18kHz offset from carrier causing degrading adjacent channel power when using EV9810 to generate modulation.	Insufficient issoluation between EV9980 and EV9810 power supplies	Ensure sufficient de-coupling between power supplies or use separate bench power supplies for EV9810 and EV9980.
RF output from 400MHz PA is low (e.g. +27dBm mean)	Voltage drop in wires to PA results in a low supply voltage	Measure the PA supply voltage at the PA pin. Increase supply voltage so that at least 3.6V is seen at the pin. NB: Do not exceed manufactures absolute maximum value when the PA is not transmitting.

Table 6 – Closed Loop possible errors

6.5.2. Open Loop Operation

Error Observed	Possible Cause	Remedy
No RF Output	Relevant circuitry not enable, or IQ signals not applied.	Try re-enabling circuitry in CMX998 or measure IQ signal at TL1.

Table 7 – Open Loop possible errors

7. Performance Specification

7.1. Electrical Performance

7.1.1. Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the Evaluation Kit.

	Min.	Max.	Units
Supply Voltage (V_{IN} - V_{SS})	0	8.0	V
Supply Voltage (V_{PA} - V_{SS})	0	4.0	V
Current into or out of V_{IN}, V_{PA} and V_{SS} pins	0	+2.0	A
Current into or out of any other connector pin	-20	+20	mA

7.1.2. Operating Limits

Correct operation of the Evaluation Kit outside these limits is not implied.

	Notes	Min.	Max.	Units
Supply Voltage (V_{IN} - V_{SS})		5.25	8.0	V
Supply Voltage (V_{PA} - V_{SS})	1	3.0	3.6	V

Notes:

1. PA supply voltage should be measured at the Power Amplifier (U2 or U5) power supply pin.

7.1.3. Operating Characteristics

For the following conditions unless otherwise specified:

V_{IN} - V_{SS} = 7.2V, V_{PA} - V_{SS} = 3.6V, Tamb = +25°C.

	Notes	Min.	Typ.	Max.	Units
DC Parameters (Excluding PA Supply)					
I_{DD} (CMX998 powersaved)	2	–	4	–	mA
I_{DD} (All CMX998 Circuitry Enabled)	2	–	135	–	mA
AC Parameters					
Up-Converter Output					
Output power		–	0	–	dBm
Attenuator Range		0	–	30	dB
Atenuator Step Size		–	2.5	–	dB
Down-Converter Input					
Input impedance		–	50	–	Ω
Input Level		-22	–	+7	dBm
Attenuator Range		0	–	29	dB
Attenuator Step Size		–	1.0	–	dB
IQ Input Signal					
Amplitude		–	0.5	–	Vp-p
DC Level		–	0	–	VDC
LO Input					
Input impedance		–	50	–	Ω
Frequency range		200	–	2000	MHz
Input Level		-10	–	-5	dBm
400MHz PA Output					
Input impedance		–	50	–	Ω
Frequency range		390	400	410	MHz
Output Level (PEP)	3		+32		dBm
Adjacent Channel Power	4		-60		dBc
800MHz PA Output					
Input impedance		–	50	–	Ω
Frequency range			800		MHz
Output Level (PEP)			+33		dBm
C-BUS Interface					
See CMX998 Datasheet					

Notes:

2. PCB current consumption, not current consumption of the CMX998.
3. +32dBm is generally achieved with continious operation, +33dBm can be achieved using burst transmission typical in TDMA systems
4. Using TETRA π/4-DQPSK modulation at 18ks/s, 18kHz measurement bandwidth for adjacent channel power.

7.1.3 Operating Characteristics - Timing Diagrams

Please refer to CMX998 Datasheet for details.

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